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Conservation Effects Assessment for Irrigated Agriculture: Upper Snake-Rock Watershed, Idaho

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Abstract. *The Upper Snake-Rock (USR) watershed is one of eight special emphasis watersheds in the NRCS Conservation Effects Assessment Project (CEAP). Land use in the USR is 37% irrigated agriculture, <1% dryland agriculture, and 60% rangeland and forest with a history of various conservation practices and long-term water quality data. The project is focused on the Twin Falls irrigation district, which covers 82,000 ha of irrigated agriculture. The main conservation practice affecting water quality is conversion from furrow irrigation to sprinkler irrigation; however, other conservation practices implemented in the watershed include reduced tillage, sediment basins, and application of polyacrylamide in irrigation water. Watershed-scale water quality research in irrigated regions of the arid west must consider the elaborate canal and drainage systems that modify hydrology. Furthermore, in arid regions, the volume of surface runoff from scheduled irrigation events is much greater than from natural runoff. The objectives of this study are to i) determine the effects of conversion from furrow irrigation to sprinkler irrigation on surface water quality and quantity at the watershed scale and ii) determine the salt balance for the Twin Falls irrigation district. Water quality will be monitored within watershed sub-basins and related to cropping practices through the use of historical data and computer simulation models. Preliminary data suggest that sprinkler irrigation results in lower TSS and P concentrations in irrigation return flow than does furrow irrigation. Additional data must be collected prior to thorough data analysis.*

Keywords. irrigation systems, water management, water quality, conservation, CEAP, furrow irrigation, sprinkler irrigation.

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Introduction

The Conservation Effects Assessment Project (CEAP) was initiated following increased funding for conservation programs in the 2002 Farm Bill. CEAP goals include (a) the assessment of conservation practice effects on soil quality, water quality, and water conservation; (b) development of regional watershed assessment models to address benefits of conservation practices; (c) development of water quality, soil quality, and water conservation databases to evaluate the effects of conservation practices; and (d) expansion of watershed scale research related to conservation practice effectiveness (NRCS, 2004). The Upper Snake-Rock (USR) watershed is one of eight special emphasis watersheds in the CEAP effort and was chosen to specifically assess the effects of conservation practices in irrigated agriculture. The USR watershed is located in south-central Idaho (Figure 1) and receives less than 25 cm of precipitation annually, most of which occurs during winter months. Land use within the USR is 37% irrigated agriculture, < 1% dryland agriculture, and 60% rangeland and forest land. Conversion from furrow to sprinkler irrigation is the primary NRCS funded conservation practice affecting surface water quality and quanity; however, other conservation practices implemented in the watershed include reservoir and reduced tillage, nutrient management, constructed wetlands, sediment basins, and application of polyacrylamide (PAM) in irrigation water.

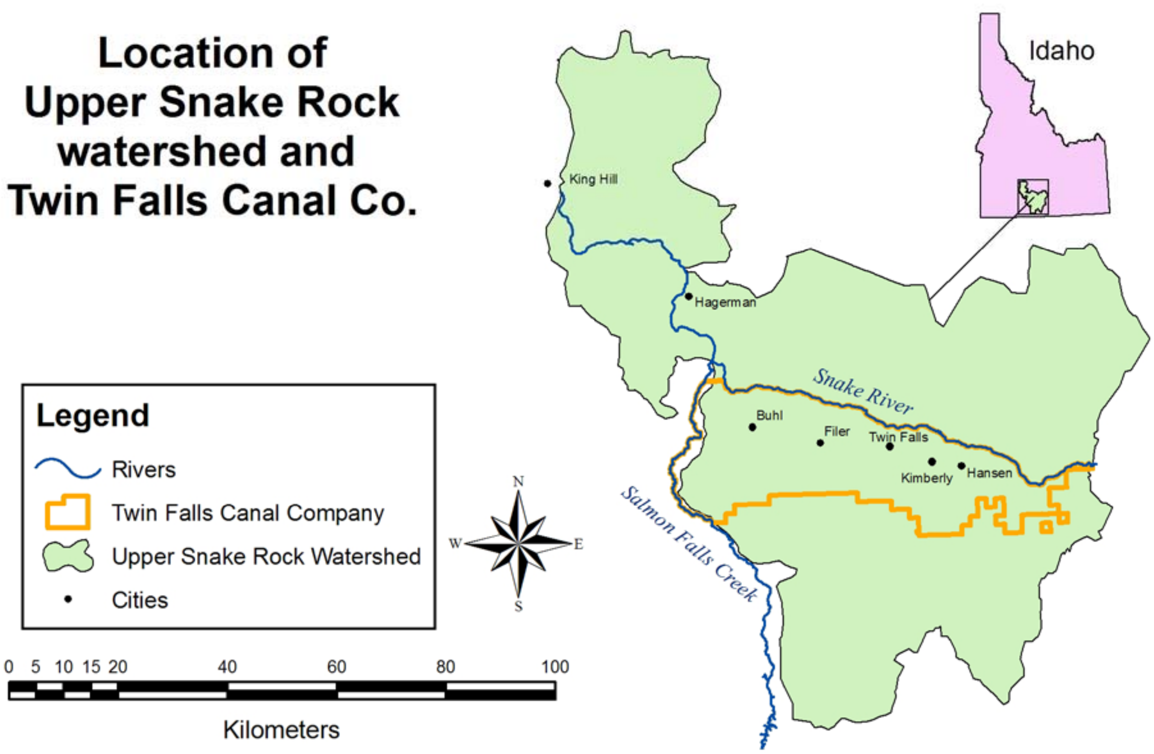

Figure 1. Location of the Upper Snake rock watershed and the Twin Falls Canal Co.

The USR CEAP project is focused on assessment of conservation practices within the Twin Falls irrigation tract, an 820 km^2 agricultural area in which the irrigation water is controlled by the Twin Falls Canal Co. (TFCC) (Figure 1). Major crops grown in this area include alfalfa, small grains, corn, sweet corn, dry beans, sugar beets, and potatoes. Approximately 30% of the crop land is irrigated by sprinkler with the remaining 70% irrigated by furrow irrigation. The objectives of the research project are to (i) conduct a water and salt balance for the Twin Falls Canal Co. and compare results to a water and salt balance conducted prior to the start of sprinkler conversion, and (ii) determine the effect of conversion from furrow to sprinkler irrigation on the quantity and quality of irrigation return flow.

Research Design and Methods

Salt Balance Study

The water and salt balance will be conducted by monitoring water imports and exports to and from the TFCC for 2 years. Water inputs will be determined from the canal co. diversion records. Water leaving the tract will be monitored at 21 return flow sites along the Snake and Salmon Falls rivers (Figure 2). The only other surface water entering the tract is in Rock Creek, which will also be monitored as it enters the tract. Ground water quality is indirectly measured as winter flow is primarily from seeps and springs within the irrigation tract. Precipitation data will be collected from area weather stations. Water loss through evapotranspiration will be calculated for all land within the TFCC that is located down-stream of Murtaugh Lake. Water samples will be collected on a regular basis from irrigation water entering the tract and the return flow sites. Irrigation return flows and streams are designated as primary, secondary, or tertiary sites (Figure 2). Primary sites have automated flow monitoring and automated samplers collecting weekly temporal composite samples (one sub-sample every 5 hours). Secondary sites have automated flow monitoring and weekly grab samples. Tertiary sites have weekly flow measurement and weekly grab samples. Water samples will be analyzed for the following constituents:

- total suspended solids (TSS), pH, EC, and temperature,
- dissolved NO_3^-, NH_4^+ P, Ca, Mg, K, Na, Fe, Zn, Al, Mn, S, and Cl,
- sediment associated N, P, Ca, Mg, K, Na, Fe, Zn, Al, Mn, and S.

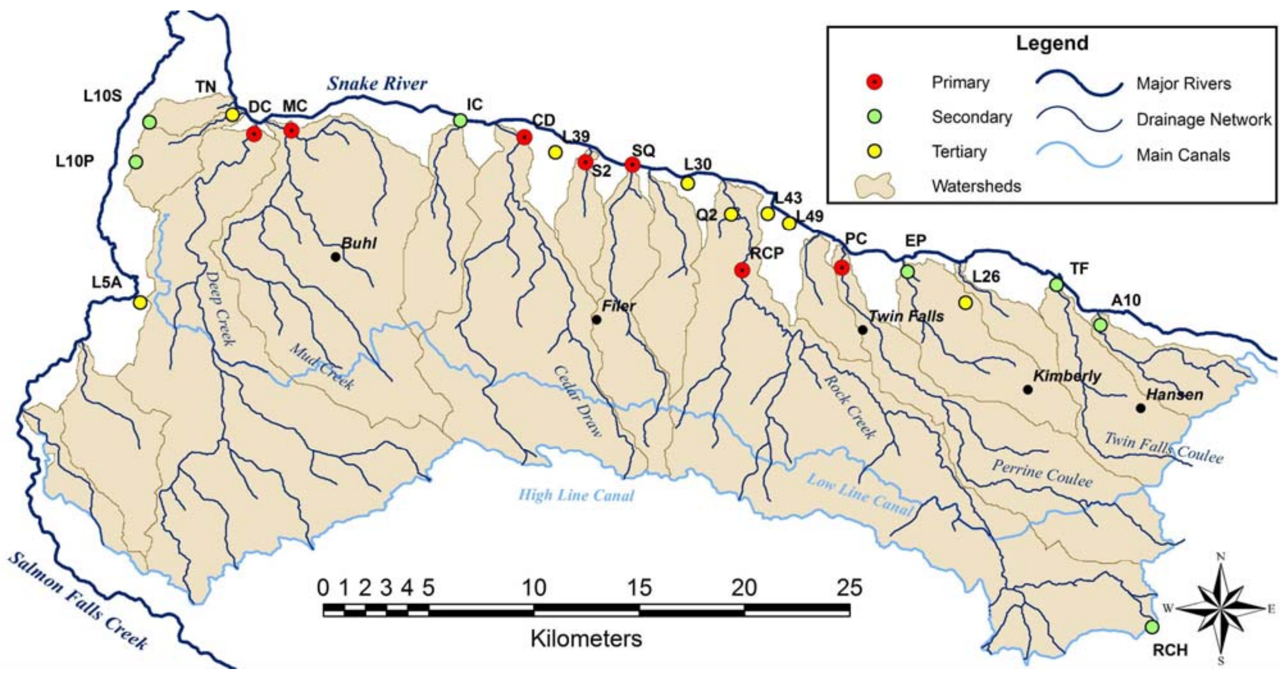

Figure 2. Return flow monitoring sites for the Twin Falls Canal Co.

Multiple Watershed Study

A multiple watershed approach has been taken to determine the effect of converting from furrow to sprinkler irrigation on a smaller scale. Six sub-basins within the TFCC, ranging in size from 140 to 620 ha, were selected for intensive monitoring (Figure 3). Sub-basins were selected to represent a broad range of irrigation practices while minimizing other variables affecting water quality (Figure 4, Table 2). Sub-basin outlets are equipped with automated flow monitoring instrumentation and an automated sampler that collects 3 to 5 flow-weighted composite samples each week (each sample is a composite of 10 sub-samples). Irrigation water is sampled weekly and canal company records are used to determine the quantity of irrigation water entering each sub-basin. Sample analysis is the same as listed for the salt-balance study (see above).

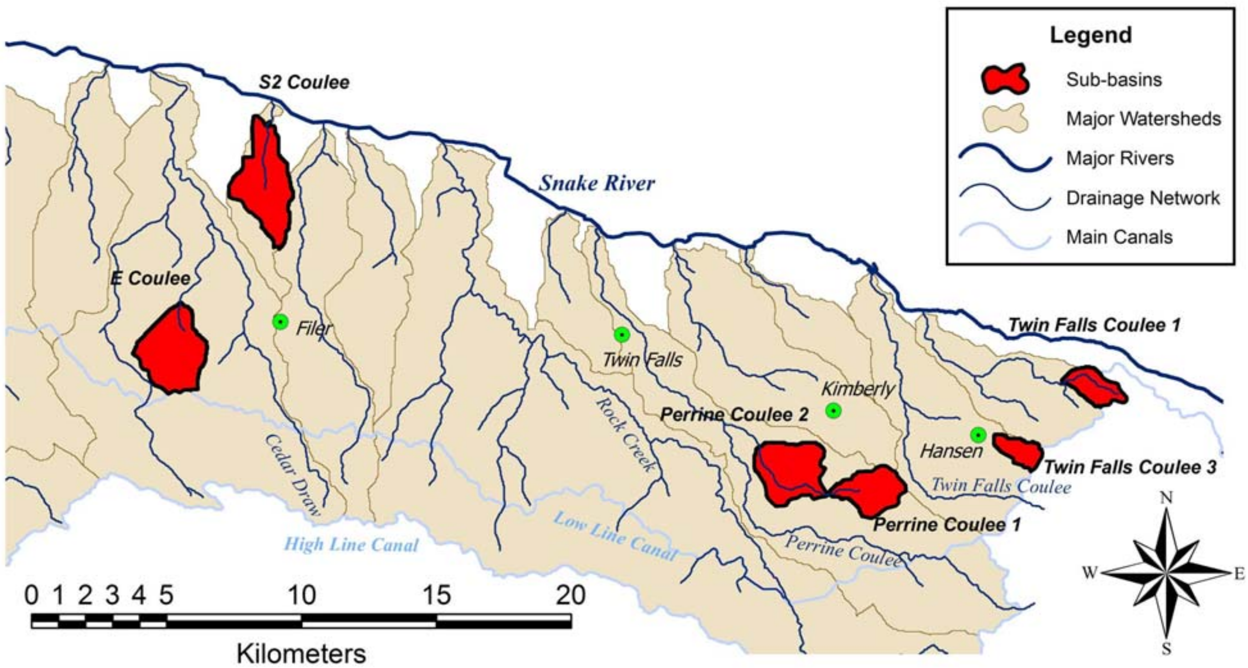

Figure 3. Sub-basins monitored for the multiple watershed study to determine the effects of conversion from furrow to sprinkler irrigation.

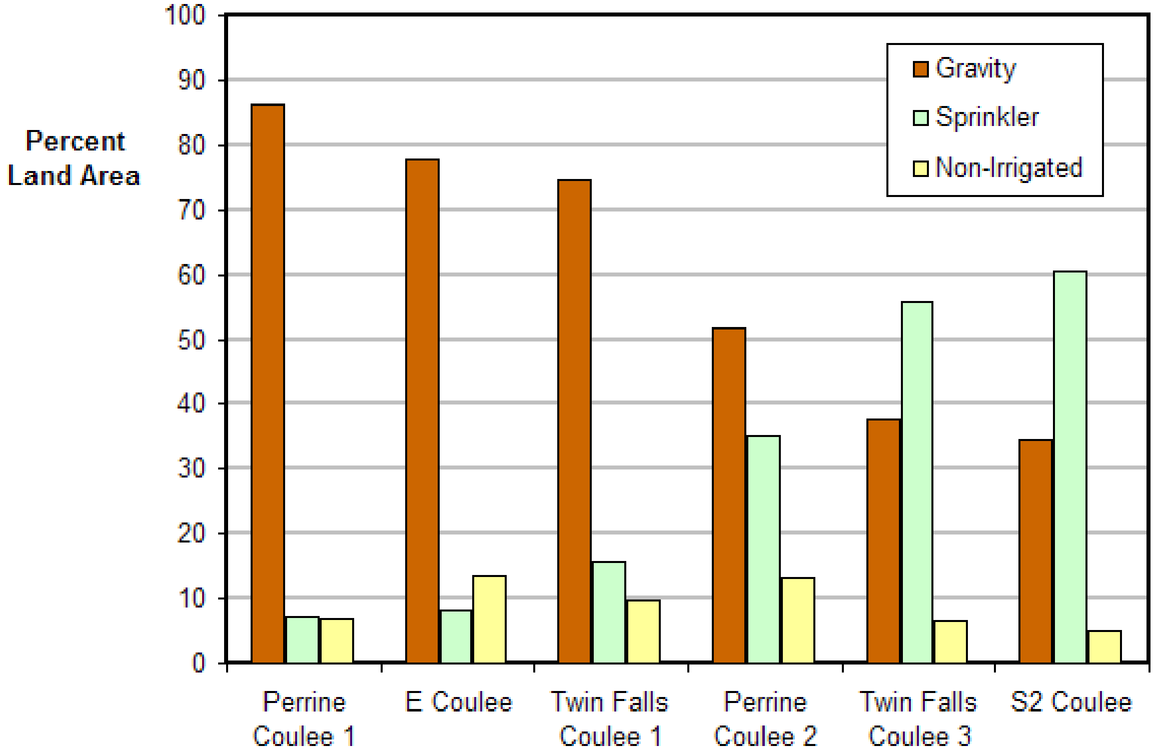

Figure 4. Relative distribution of irrigation practices among the 6 sub-basins chosen for the multiple watershed study.

Table 1. Sub-basin characteristics affecting water quality.

Sub-basin	watershed area (ha)	AFO† within watershed	AFO near watershed	Sediment Basins§	Seeps‡	Major Soil Series	Slope (%)
Perrine Coulee 1	320	0	0	2	No	Portneuf Silt Loam	0 to 2
E Coulee	587	0	2	2	Yes	Minveno Silt Loam	2 to 8
Twin Falls Coulee 1	194	1 (very small)	1	3	No	Portneuf Silt Loam	2 to 4
Perrine Coulee 2	489	0	1	2	No	Portneuf Silt Loam	0 to 2
Twin Falls Coulee 3	138	0	0	1	No	Portneuf Silt Loam	2 to 4
S2 Coulee	619	0	0	4	Yes	Portneuf Silt Loam	0 to 2

† Animal Feeding Operations

§ Approximate

‡ Shallow ground water returns through springs and tile drains

Preliminary Results

Spring precipitation in 2005 was over double the long-term average for April and May, delaying the irrigation season, therefore, data prior to May 20, 2005 will not be presented. Data from the salt balance study is intended to be analyzed on an annual basis. However, preliminary results show that dissolved P concentrations tend to increase moving down-stream (east to west) in the irrigation tract, with the exception of Deep Creek (Figure 5).

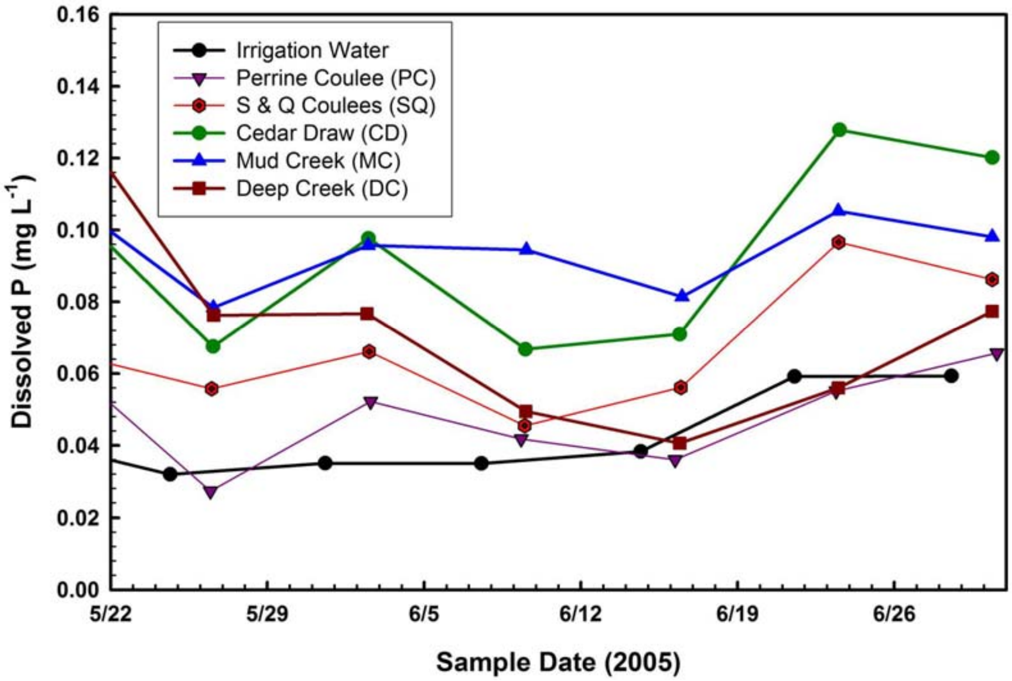

Figure 5. Dissolved P concentrations from major streams draining irrigated land from the Twin Falls Canal Company.

Although nutrient concentrations in irrigation return flow are greater than in the diverted water, the total nutrient and sediment loads returned to the Snake River can be less than the amount diverted. For example, during the 4-week period from May 29 to June 26, 2005, the dissolved P load returned to the Snake River from the Twin Falls Canal Co. was approximately half as large as the dissolved P load diverted during the same period even though the flow-weighted dissolved P concentration in return flow was double the concentration in diverted water (Table 2). This is because the quantity of water returned to the Snake River was only about 1/3 of the amount diverted. These comparisons are expected to change throughout the irrigation season as small grain crops are harvested and row crop irrigation increases.

Table 2. Water volume, nutrient/sediment concentrations, and nutrient/sediment loads in diverted irrigation water and irrigation return flow from May 29, 2005 to June 26, 2005 for the Twin Falls Canal Co.

Source	Water Volume (m^3)	Dissolved NH_4	Dissolved NO_3	Dissolved P	Total Suspended Solids
		Flow-weighted concentrations (mg L^{-1})			
Irr. water		0.14	1.93	0.04	16.9
Irr. return flow		0.08	2.81	0.08	52.4
		nutrient/sediment load (kg)			
Irr. water	134,300,000	18,500	259,000	5,800	2,270,000
Irr. return flow	41,360,000	3,100	116,000	3,100	2,170,000
Balance	-92,940,000	-15,400	-143,000	-2,700	-100,000

The multiple watershed study showed that total suspended solids (TSS) concentrations tended to decrease with increasing sprinkler irrigation (Figure 6). Total suspended solids concentrations at sub-basin outlets remained greater than the TSS concentrations in irrigation return to the Snake river (data not shown), indicating impacts of other factors, such as sediment ponds, water reuse, and in-stream deposition, on TSS. Similar to TSS, dissolved P concentrations also tended to decrease with increasing sprinkler irrigation, However, the effect of conversion to sprinkler irrigation is less apparent for dissolved P than for TSS (Figure 7).

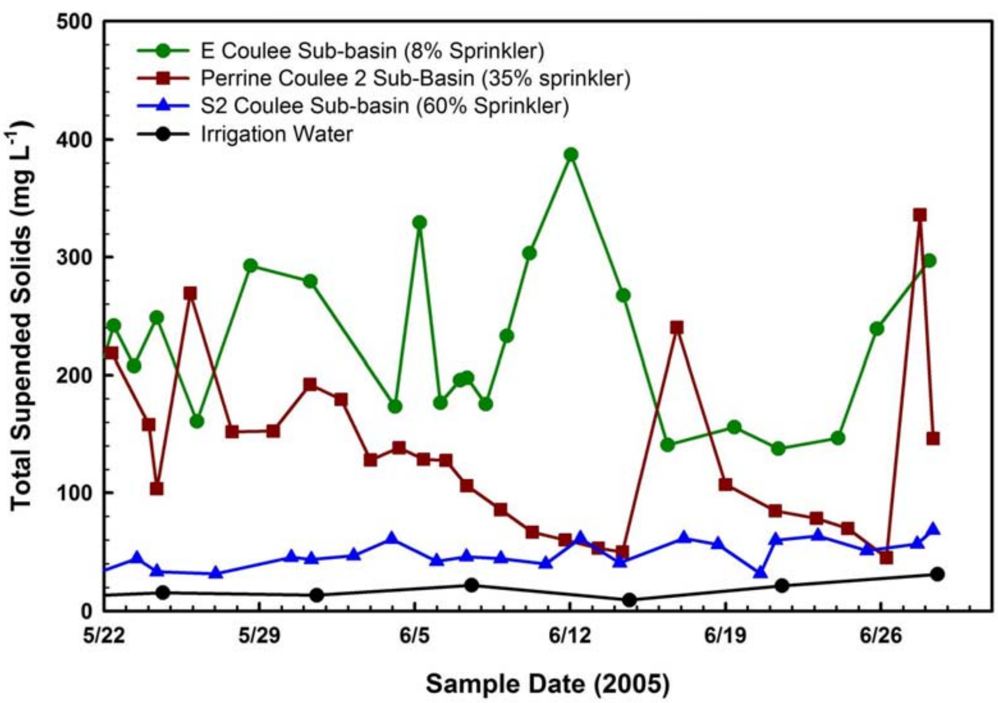

Figure 6. Total suspended solids concentrations in irrigation tail water exiting the three largest sub-basins used for the multiple watershed study.

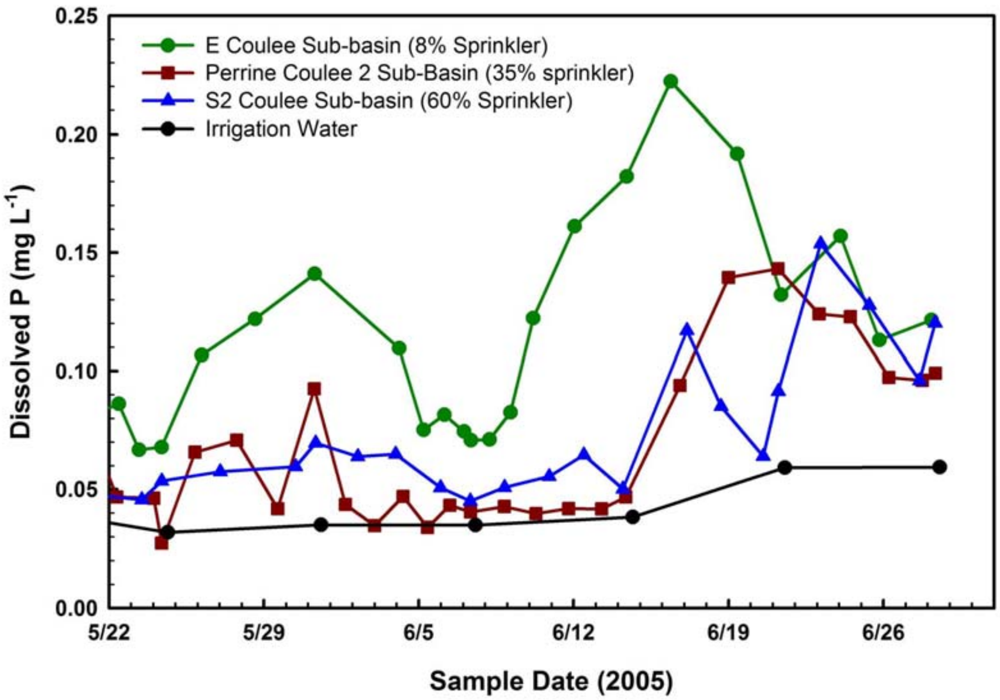

Figure 7. Dissolved P concentrations in irrigation tail water exiting the three largest sub-basins used for the multiple watershed study.

Future Plans

Irrigation return flow for the salt balance study and the multiple watershed study will continue to be monitored through the end of 2006. Climate data will be collected to determine evapotranspiration losses and compute an annual water balance for the TFCC and for each of the 6 sub-basins. The annual water balance will be paired up with water quality data to determine total sediment, N, and P losses from each monitoring point. A more thorough data analysis will be completed following these computations.

Future plans also include configuration, calibration, and validation of a watershed scale water quality model based on currently available models such as SWAT, APEX, or Ann-AGNPS. This model will then be used to evaluate effects of landscape position on the effectiveness of conservation practices as well as predict the potential effects of future conversion to sprinkler irrigation on water quality.

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